Layered nonhomogeneous curved beam elements for inelastic analysis

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Computers and Structures
Vol. 4, Issue., 1990

Abstract: A general materially nonlinear formulation using Timoshenko layered nonhomogeneous (composite) curved beam elements is presented. Axial, bending, and shear deformations are considerd. The formulation is written in a general way so that the element can have any number of nodes, depending on the shape functions which are chosen. The element may be nonprismatic with any number of layers and could be composed of a brittle material, or a combination of both. The general plasticity theory, including hardening, softening, and cracking, is incorporated into the formulation using several failure criteria for ductile and brittle materials. An incremental-iterative solution algorithm utilizing initial stiffness, tangential (Newton-Raphson) stiffness, or Forward Euler method is employed. To gauge the performance of the elements, several examples, which cover a wide range of applications, are solved, and the results are compared with the experimental and/or theoretical values. Steel and reinforced concrete structures with shallow and deep sections are studied; straight as well as curved members are considered.